Mobile technologies and learning

learning and skills development agency

A technology update and m-learning project summary

Jill Attewell
Technology Enhanced Learning Research Centre

m-learning

Our m-learning project partners

CRMPA

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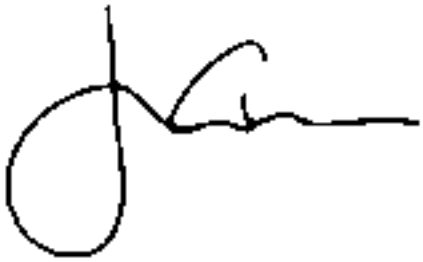
Preface

In 2001, when the m-learning project commenced, few people knew about the concept of mobile learning or, indeed, could envisage the potential of mobile devices for learning.

The m-learning project – funded by the European Commission, the project partners and (in England) the Learning and Skills Council – was considered highly innovative and unusual. It not only involved developing learning materials to run on handheld devices in a time of rapid technological development, but also targeted reluctant young adult learners with poor literacy or numeracy.

I am delighted that the Learning and Skills Council has been closely involved with this research and development project, and I am even more delighted at the many innovative and exciting ways that have been identified through the project for making learning more accessible and appropriate for all learners.

Key findings from the learner research and systems trials phase of the project are included in this publication. These findings indicate that mobile devices can be used successfully to involve some of the hardest to reach and most disadvantaged young adults in learning. As a result, and especially as part of a blended learning strategy, mobile learning has the potential to help these young people to improve both their skills and their self-confidence and, therefore, their life chances.



Jon Gamble
Director of Adult Learning
Learning and Skills Council

Section 1 Introduction

The aims of this publication are to:

- provide an update on the development of mobile phone technologies with the potential for supporting and/or delivering some elements of teaching and learning processes
- report briefly on the work and key findings of the m-learning research and development project, which completed 3 years of work in September 2004. Full details of the project findings can be found in a separate research report. This report and further information about the project is available via the LSDA (www.LSDA.org.uk) and m-learning (www.m-learning.org) websites.

The m-learning project was funded by the European Commission's Information Society Technologies (IST) initiative with matched funding from the project partners and, in the UK, the Learning and Skills Council. There are five project partners: two university-based research units (Ultralab at Anglia Polytechnic University in the UK and Centro di Ricerca in Matematica Pura ed Applicata (CRMPA) at the University of Salerno in Italy), two commercial companies (Cambridge Training and Development Limited (CTAD) in the UK and Lecando in Sweden) and the Learning and Skills Development Agency (LSDA) in the UK.

Section 2 Mobile phone technology update

2.1 Mobile phones

There are estimated to be 1.5 billion mobile phones in the world today (Prensky, 2004). This is more than three times the number of personal computers (PCs), and today's most sophisticated phones have the processing power of a mid-1990s PC.

These facts, and the range of computer-like functionality offered by top-of-the-range devices, are leading some observers to speculate that many people in the not so distant future will start to see the mobile phone as an alternative to a PC. For example Jeff Hawkins, inventor of the Palm Pilot, was recently quoted (Stone 2004) as saying, 'One day, 2 or 3 billion people will have cell phones, and they are not all going to have PCs … The mobile phone will become their digital life'. Sean Maloney, an executive vice-president at Intel (also interviewed by Stone) disagrees, on the grounds that, 'Hundreds of millions of people are not going to replace the full screen, mouse and keyboard experience with staring at a little screen'. Clearly, neither view is likely to be completely objective, but the fact that the debate is happening is an indication of how powerful and sophisticated mobile devices are becoming.

In the m-learning project we chose to provide learners taking part in our learner research and learning materials and systems trials with the most sophisticated devices available at the time in an attempt to ensure that our findings do not become out of date too quickly. We tried to focus on the types of devices that will be owned by, or reasonably easily accessible to, our target audience (16–24 year olds not in full-time education or training) within 2 or 3 years of the end of the project. We are aware that the hybrid mobile phone/personal digital assistant (or PDA) devices we used (sometimes known as 'smartphones') currently make up only a relatively small percentage of mobile phone sales. However, sales are growing and the potential market for 'smartphones' is thought to be much bigger than the handheld computers market; indeed, 'smartphones' overtook sales of PDAs in 2003. Market research from Gartner, Canalys and others (quoted by van Grinsven 2004) indicates that 'in four to five years, global sales of "smartphones" will reach 170 million, compared with slightly more than 20 million this year'. Also, the very rapid and widespread adoption of camera phones suggests that our target audience is willing to invest in more expensive devices if they are attractive enough and offer significant actual or perceived benefits. Sales of camera phones exceeded those of digital cameras for the first time in 2003, when camera phone sales increased almost fivefold from 2002, resulting in 84m unit sales.

The modern mobile phone market caters for a wide variety of customer tastes and lifestyles. Some phones are tiny and discreet, some are chosen for their appearance (like a fashion accessory, with alternative covers that allow that appearance to be changed to match the owner's outfit), some just offer basic functionality while some others provide a wide range of business and leisure services to their users. Manufacturers are marketing diverse product ranges, including devices that specialise in providing particular services or are aimed at particular users. Instead of describing a product as a mobile phone, manufacturers often use descriptions like 'game deck', 'communicator' or 'mobile multimedia machine'.

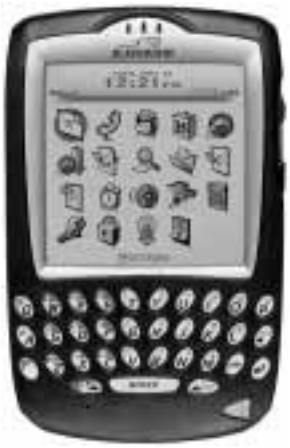
Most new phones now include some games, and all but the cheapest models offer downloading of additional games. There are large numbers of games available that can be purchased and downloaded for a few euro each. An increasing number of mobile phone models are being marketed as games phones. The ultimate example of this is the Nokia N-Gage QD game deck, which is primarily a portable games machine but can also be used as a phone. Gamers are able to play together as well as individually thanks to Bluetooth (a short-range radio technology which allows electronic devices to exchange information) and access to an online player community service called the N-Gage Arena.

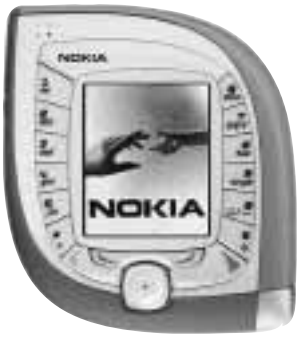
Some devices are aimed at business users and are marketed primarily as business communications devices. To aid e-mail communication they include a physical qwerty keyboard and a large screen. Examples are the BlackBerry and the Nokia 6810 and 6820 messaging devices.

Other combined business and leisure PDA/phone hybrid machines and 'smartphones' include a virtual pop-up qwerty keyboard and handwriting recognition. They also include some or all of the following: still, and in some cases, a video camera, music player, radio, voice memo recording, games, e-mail, internet, and organiser functions. Examples are the O_2 X3 and the Sony Ericsson P900.

Third generation (3G) handsets allow users of 3G services to view video content including music videos and football game highlights. With several new 3G services being launched in time for Christmas 2004, the 3G phones are expected to become more popular. However, it seems that the next big thing in mobile phones may be television. TV phones have recently been launched in some gadget-loving countries (eg South Korea and Japan). These are capable of receiving satellite TV channels and some phones have a plug-in device that allows playing of pre-recorded terrestrial broadcasts.

Top to bottom
Nokia N-Gage QD
BlackBerry
Nokia 7600
Sony Ericsson P900





2.2 **Infrastructure**

Sales of advanced handsets such as those described above and the development of value-added non-voice services are growing. Mobile network operators around the world are hoping to emulate the success of operators in Japan and South Korea. Many network operators are launching third generation (3G) networks in 2004 and 2005, and these promise fast, broad bandwidth connections, enhanced multimedia and advanced services such as video conferencing. However, most observers believe that full availability and mass adoption of 3G services will take a few more years.

Many companies are still experimenting with ways of making money from mobile data using the current GSM or 2G networks and the so-called 2.5G networks (2.5G is 2G with faster and more efficient data transmission resulting from transmitting messages in labelled 'packets', thus allowing many users to share a single connection).

2.5G networks are enabling subscribers to access a wide selection of new non-voice services and operators hope that consumer familiarity built now will lead to 3G mass adoption later. Meanwhile, the performance of 2.5G networks will be improved by the new EDGE technology. EDGE (Enhanced Data Rates for GSM Evolution) is a technology that increases capacity, improves quality and allows use of advanced services over the existing GSM network. EDGE is an upgrade of the GPRS (General Packet Radio Services) system for data transfer in GSM networks. The Norwegian telecommunications company Telnor claim (Johnsen 2004) that the EDGE data transfer rate is substantially faster than possible speeds using GPRS technology and can reach between 100 and 200 kbit/s under perfect circumstances. EDGE implementation does, however, require upgrades to both base stations and mobile phones.

2.3 **Viruses**

A computer virus, believed to be the first spread by mobile phones, has recently been sent to anti-virus firms. No infections have been reported, and this virus is harmless, but it is proof that mobile phones could be at risk from virus writers. The virus, known as Cabir, infects phones and devices running the Symbian operating system and can be passed to other devices via Bluetooth. Requiring Bluetooth to travel significantly restricts the threat posed by the worm as it is thereby constrained to a radius of about 30 metres. Also, transfer is dependent upon a nearby phone user having Bluetooth turned on and accepting the virus in spite of it being preceded by a warning that the source of the file is unknown. For now, the Windows operating system is still the primary target for virus writers and they do not seem very interested in mobile devices. Indeed, the first virus for a Palm device was detected in 2000 and it has not, to date, resulted in a problem for PDA owners.

2.4 **Health and safety**

The Independent Expert Group on Mobile Phones (IEGMP) in the Stewart Report (Stewart 2000) recommended further research be carried out into possible effects of mobile phone use on health. The National Radiation Protection Board's (NRPB) independent Advisory Group on Non-Ionising Radiation (AGNIR: Chairman, Professor Anthony Swerdlow) subsequently examined recent (ie post-Stewart) experimental and epidemiological evidence for adverse health effects caused by exposure to radiofrequency (RF) transmissions, including those associated with mobile telephone handsets and base stations.

AGNIR has concluded (AGNIR 2003) that there is no biological evidence for mutation or tumour causation by RF exposure, and epidemiological studies overall do not support causal associations between exposures to RF and the risk of cancer, in particular from mobile phone use. AGNIR found a number of studies that suggested possible effects on brain function at RF exposure levels comparable with those from mobile phone handset use. However, AGNIR regarded the overall evidence as inconclusive.

AGNIR did not state that mobile phones have been proven to be entirely risk free. It identified the limitations of the published research and concluded that: 'In aggregate the research published since the Stewart report (Stewart, 2000) does not give cause for concern. The weight of evidence now available does not suggest that there are adverse health effects from exposures to RF fields below guideline levels, but the published research on RF exposures and health has limitations, and mobile phones have only been in widespread use for a relatively short time. The possibility therefore remains open that there could be health effects from exposure to RF fields below guideline levels; hence continued research is needed.' For more information see www.nrpb.org/advisory_groups/agnir/index.htm.

The NRPB have published a further report (NRPB, 2004) and a literature review (Sienkiewicz and Kowalczuk, 2004) which brings together the findings of 26 reports on mobile phones and health prepared by other national and medical bodies including an Expert Panel of the Royal Society of Canada (Royal Society of Canada 1999), the Department of Health in France (Zmirou et al. 2001) and the Health Council of the Netherlands (NCN, 2002) as well as the British Medical Association's (BMA) interim report (BMA 2001). NRPB found that the conclusions of these studies are very similar to those of the Stewart and AGNIR reports in relation to possible health effects from exposure to RF from both mobile phones and base stations. The Health Council of the Netherlands (HCN) differed a little from the others in that this was the only report that did not consider it necessary to recommend a precautionary approach of limiting mobile telephone use by children. HCN concluded that 'there is no reason to recommend that children should restrict the use of mobile telephones as much as possible'. In contrast the original Stewart Report (Stewart, 2000) stated that 'if there are currently unrecognised adverse health effects from the use of mobile phones, children may be more vulnerable,' and recommended that 'the widespread use of mobile phones by children for non-essential calls should be discouraged.'

Section 3 The m-learning project

3.1 m-learning project platforms and systems

Platforms

A Technology Selection Roadmap, describing available and in-the-pipeline technologies and our assessment of their potential relevance and utility, was developed early in the project and was updated to take into account new technologies as they emerged and to reflect our experiences. The process of drawing up the roadmap assisted decision-making about which hardware and software to use. When internet browsers became available on some devices we decided that these should form a major strand of our technology platform strategy. We believed that the delivery of learning materials within a browser would give us a great deal of platform independence, enabling our materials to be easily ported between different existing and predicted devices.

In practice, we found that, because of the immature nature of standards development and implementation in the mobile phone/PDA arena, browser delivery has resulted in much less platform independence than anticipated. As a result, additional development work had to be dedicated to ensuring that learning materials designed for one phone or PDA worked on others. Also, rather than developing one generic version of learning materials that can be used on all platforms, we developed some materials, or versions of materials, specifically to take advantage of the strengths of particular platform types.

In phase 2 of the project (2003–04) we focused primarily on two platform types:

- hybrid PDA/phone devices running the Pocket PC operating system
- hybrid phone/PDA devices running the Symbian operating system.

The PDA/phone hybrids are typically a corporate rather than personal device and are increasingly being employed for business communication, data access and mobile training. They are also the kind of device that companies and institutions have started to purchase as a more convenient, though less powerful, alternative to a laptop computer. The Symbian phone/PDAs, although currently rather expensive for many mobile phone owners, are perceived as a phone rather than a PDA and therefore are more immediately attractive to the project's target age group. We know from a survey we carried out in phase 1 of our project that our target age group tend to consider PDAs to be business machines and not relevant to themselves (results from a survey conducted with 746 young people in seven UK cities and towns).

We have also developed some learning materials for Java-enabled mobile phones (most phones launched in the last couple of years support Java) and some SMS (text messaging) materials that can be used on any mobile phone.

Systems

Learner access to m-learning project systems and materials was via a microportal (mPortal), which consists of a series of mini web pages with navigation pointing to:

- learning materials
- mini web Page Builder tools
- a collaborative activities tool (the mediaBoard)
- peer-to-peer communication services (messages, chat, discussion and blogs)
- the learning management system
- simple help guides for the system
- links to places on the Web that may be helpful or interesting for our target audience (eg alcohol, drugs and sexual health advice services, job hunting and online learning services and dictionaries).

The mPortal also manages the 'behind the scenes' integration and security.

The Page Builder tools within the mPortal allow learners to create and edit their own mini web pages for viewing on mobile devices (and also accessible from a desktop computer) in a password-protected environment. The pages learners create can contain a number of different elements including text, pictures, movies, animations, audio, blogs (a short version of the term 'web log', meaning a publicly accessible web-based journal), conversations and links to any web pages chosen by the learner.

The learning management system – Intelligent Web Tutor (IWT) – includes a repository for online learning materials and learner tracking functionality. IWT includes access to an intelligent tutor system – Learner Intelligent Agent (LIA) – that selects modules for learners based on their preferences and progress to date, and a Knowledge Representation Tool (KRT), which allows tutors to create/import/export courses and modules.

3.2 m-learning project materials

Demonstrations of some of the learning materials developed are available on the m-learning project website at www.m-learning.org. These can be viewed on a PC or on mobile devices. Learners can access materials online via the mPortal/learning management system/intelligent tutor or use offline learning materials downloaded to the PDA/phones. We decided to offer both online and offline access in order to provide a better user experience (ie one in which minimal inconvenience and interruption is caused by disruption to, or reduced quality of, signal while learners are on the move or in remote locations). Work-in-progress learning materials have been demonstrated at many events during the project and small groups of learners have tested materials and provided feedback. Feedback from sessions in phase 2 of the project has been extremely positive and suggestions have been made for different kinds of materials that would also be useful. For example, materials for learners at UK Adult Literacy/Numeracy Curriculum Entry levels 1 and 2 were suggested, as most of the materials developed by the project are designed for Entry level 3 and UK Adult Literacy/Numeracy Curriculum level 1 learners (ie those who have basic literacy and numeracy but need assistance to develop more comprehensive and sophisticated skills).

As reported above, the immature nature of standards development and implementation has meant that development of one generic version to run on all platforms is not currently possible. Therefore, we have developed some materials, or versions of materials, specifically for particular platforms, resulting in the categories of learning materials listed below.

Learning materials for hybrid PDA/mobile phone devices running the Microsoft Pocket PC operating system

We decided to use the XDA II as our Pocket PC handset because of its updated operating system, improved web browser and support for Flash 6. The learner's visual and audio experience, when using downloaded materials, is similar to accessing web-based learning materials via a PC although, of course, on a smaller screen.

Learning materials for the Sony Ericsson P800/P900 hybrid mobile phone/PDA

We selected the P800 as our Symbian handset and soon afterwards an upgraded version of this handset, the P900, was released. Unfortunately, none of the Symbian phones available support Flash 6 and therefore most of the learning materials that we developed for the Pocket PC PDA/phone devices will not work on these phones. Also, when using the standard web browser, supplied learning materials cannot be cached on the phone and therefore have to be used online only. An alternative web browser, Opera, can be installed on these phones and may solve this problem.

Mobile phone J2ME quiz games

Java 2 Platform, Micro Edition (J2ME) allows programmers to use the Java programming language and related tools to develop applications for mobile wireless information devices such as mobile phones and PDAs. Currently, most new phones support Java, and an increasingly large number of games are being developed using J2ME and marketed to mobile users.

For our learner research and systems trials we pre-loaded these quiz games onto the phones the learners used. They have also been made available for downloading to any other Java-enabled phones via a WAP server.

The J2ME driving theory test game was very popular with learners who took part in our learner research and systems trials, many of whom were learning to drive or hoping to do so soon. Several of the other materials developed for the 'smartphones' also use driving as a theme for developing numeracy (eg stopping distance calculations).

Collaborative learning activities that use camera phones (including the P800/P900)

The mediaBoard is an activity tool developed to facilitate collaborative approaches to mobile learning. Multimedia messaging (MMS) is used to add visual and audio material to a web-based multimedia map or picture. Collaborating organisations have been experimenting with the mediaBoard and inventing a variety of activities that it can support. Some mentors have been very enthusiastic about the mediaBoard's potential and groups of learners have enjoyed trying it. Learners can also take part in mediaBoard activities using their own basic phones and separate cameras, with the pictures being transferred to the website later from a PC. In practice, development of the mediaBoard was more difficult and time consuming than originally anticipated, particularly because of significant differences in MMS handling between service providers.

Mobile phone text messaging quizzes

We have developed an SMS quiz engine that includes an online editing tool. We have also developed five sets of materials that match the themes used for other learning materials and complement the use of these. The approach consists of circulating a leaflet with reference information on one side and a five-question quiz on the other. Learners text in their answers and are sent a reply. This approach allows learners with the least sophisticated mobile phones to take part in some mobile learning and can be a useful and entertaining addition to any kind of classroom lesson or e-learning.

Mobile phone SMS mini language course

In collaboration with Albatros, an organisation from south Italy working for the social integration of foreign and dialect-speaking people, our Italian partners CRMPA have designed an SMS-based basic Italian language course that can be delivered to learners' own low specification mobile phones. The course structure includes 100 concepts and for each concept textual and test dialogues have been created. The learner can send the answer by simply replying to the SMS message with a further message. The system tracks the answers received from learners, verifies the results and sends them a new SMS containing test results and suggestions for improvement.

3.3 Learner research and systems trials

Equipment

The project purchased 90 mobile devices to be lent to learners (plus a few more devices for development and support work) via the collaborating organisations in all three of the partner countries. The devices acquired included 50 O_2 XDA IIs, 20 Sony Ericsson P800s and 20 Sony Ericsson P900s. Set up, maintenance, delivery and collection and first-line support of the devices was provided by the LSDA with all partners and O_2 providing second-line support and advice.

Research in Italy

The first phase of the Italian learner research and system trials involved 20 learners, aged 17–19 years, studying at the collaborating organisation Amendola High School. Mentors and learners participated with enthusiasm and many activities were organised to use the mPortal and mediaBoard. For the second phase in Italy the collaborating organisation Albatros used the SMS and voice basic Italian courses that they helped to create with 33 learners. For the voice courses the potential of VoiceXML was investigated but IVR (Interactive Voice Response) was used instead as this allowed learners to interact with the learning management system. Learners in this phase used their own mobile phones as well as the more sophisticated devices provided by the project.

Research in Sweden

In Sweden, pupils learning English in a City of Stockholm school took part in the learner research and systems trials. Training materials and data collection instruments were translated into Swedish but the learners used the same learning materials as learners in the UK.

Research in the UK

Eleven UK collaborating organisations (COs) have taken part in the research/trials activities.

An induction workshop for the UK COs was held with the objectives of:

- introducing the COs to the project team
- ensuring they understood and were committed to the aims and objectives of the project
- discussing roles and responsibilities, processes and procedures, research methods and instruments, equipment, possible problems and support arrangements.

A series of training workshops for the COs' mentors followed and a Mentors' Manual was developed. This contained information about the project, the learning materials and systems and how to access and use them, advice and guidance, user IDs and passwords, URLs and support contact details. It also contained pre- and post-activity questionnaires, interview scripts and information about how learners could provide feedback directly to the project team. English, Italian and Swedish versions of the manual were produced.

The mentors were responsible for ensuring that the learners understood the purpose of the research and were happy to take part in research activities. Mentors were also responsible for cascading aspects of the training to the learners as necessary. Very simple introductory guides to the mobile devices were developed for mentors and for learners who might be unfamiliar with the latest technology. These were provided in paper format in the Mentors' Manual and videos with voice-overs were made available via the m-learning project website.

The COs took part for varying lengths of time, between 3 and 7 weeks and involved groups of, typically, 10 or 20 learners at a time. In some cases intensive activities took place for a short period while in other cases learners undertook mobile learning only on certain days of the week over a longer period. Usually, the learners were allowed to take the devices home with them to use whenever and wherever they pleased.

Research instruments developed and used were:

- pre-research individual CO project plans and post-research review questionnaires
- pre- and post-research mentors' questionnaires
- pre- and post-mobile learning mentor assessments of their learners' abilities and attitudes
- scripts for mentor interviews with learners before and after activities (the method of interviewing by a known and trusted person was chosen rather than interview by project team members, or questionnaires, as the young people involved had poor literacy and/or numeracy skills and were, in some cases, quite vulnerable and suspicious of unfamiliar adults)
- learner feedback directly to the project team via a project mediaBoard (text messages and/or pictures) and/or by sending messages in the mPortal.

In addition to the use of these data collection instruments, some mentors were interviewed face to face and/or by telephone to collect additional unstructured or semi-structured qualitative data.

The data and the respondents in the UK, Italy and Sweden

Complete sets of data were received from a total of 128 learners (a further 33 sets of data were received from the trials of the SMS-based Italian language course and analysed separately). Three COs did not return full sets of data in time to be included in the results, but verbal and written feedback supplied by mentors and key contacts at these organisations have been incorporated into some of the general lessons arising from the findings.

The learners for whom full sets of data were received had the following characteristics:

- 51% of all respondents were female
- 49% came from educational organisations (eg further education colleges and local authority education services)
- 55% were under 19 years of age and 45% were aged 20 or above (based on 100 respondents for whom age data was provided)
- at least 89% were reported to have literacy or numeracy needs (mentors did not always provide information on this)
- at least 19 learners were at risk of dropping out of education and 59 already had
- 32 were homeless, 19 were modern apprentices, 9 were travellers (defined as: people having a nomadic lifestyle for all or part of the year) and 3 had been young offenders
- at least 80% of learners were unemployed.

3.4 Key findings

Key statistics

- The learners were mostly enthusiastic about mobile learning and 62% reported that they felt more keen to take part in future learning after trying mobile learning. Of this 62% some expressed a future preference for learning:
  - with laptops (91%)
  - on a PC (82%)
  - using mobile devices (80%)
  - with friends/people of their own age (76%)
  - at college (54%).
- Just under a third of respondents (29%) were assessed by their mentors as having developed a more positive attitude towards reading after taking part in the research.
- 82% of respondents felt the mobile learning games could help them to improve their reading or spelling, and 78% felt these could help them improve their maths.
- Of the learners who reported using the collaborative mobile learning tools, 88% enjoyed using the mediaBoard and felt that it could help people to learn and 74% felt the mPortal Page Builder had potential as a tool to help learners communicate.

Analysis of the evidence collected during our research suggests that mobile learning can make a useful contribution to attracting young people to learning, maintaining their interest and supporting their learning and development.

Key observations

Mobile learning is unique in that it allows truly anywhere, anytime, personalised learning. It can also be used to enrich, enliven or add variety to conventional lessons or courses. Analysis of the evidence collected during our research suggests that the use of mobile learning may have a positive contribution to make in the following areas:

- **Mobile learning helps learners to improve their literacy and numeracy skills and to recognise their existing abilities**

  Although the learners were involved in mobile learning for fairly short periods of time, some mentors reported perceived improvements in their learners' reading, writing and maths skills. Most improvements were noted amongst those learners initially described as being 'less able' or having 'very limited ability'. Some of these improvements seem to have been due to mentors, and learners themselves, not recognising existing abilities. One mentor reported that a learner 'perceived reading to be a book based activity but he was able to read texts and information regarding the device very well … perhaps his biggest barrier to reading is his self-evaluation of his reading ability, and negative educational experience!'

- **Mobile learning can be used to encourage both independent and collaborative learning experiences**

  Many learners taking part enjoyed the opportunity to use the mobile devices to learn independently of a group setting for a variety of reasons. For example one mentor who worked with learners experiencing housing related difficulties noted 'he preferred to work independently, as he felt under no pressure, and could do it all in the evenings' and another 'they have said it has been great being able to use materials in private. When they come into the centre it can be embarrassing because everyone can see what they are doing on the computer'. Others welcomed the opportunity to work collaboratively. For example a learner stated 'it is good learning and helping other people' and '[it is] probably better to work together with new technologies, someone to ask. It also puts some pressure on you to achieve something'.

- **Mobile learning helps learners to identify areas where they need assistance and support**

  A mentor involved in the project has been working with a homeless young adult who regularly truanted while at school and subsequently left without any qualifications. The mentor reported that as a result of participation in the m-learning project her client has not only developed a greater confidence in his current reading and writing abilities but has also been inspired to seek help to improve his mathematical skills from the local Adult Basic Education Centre. When reporting the young adult's post-trial attitude to learning the mentor noted that 'now he knows this is something that he really needs to work on and is now ready to do so'.

- **Mobile learning helps to combat resistance to the use of ICT and can help bridge the gap between mobile phone literacy and ICT literacy**

  A mentor working with a group of displaced young adults studying ESOL (English for Speakers of Other Languages) reported that, post-participation, a number of learners within the group who had previously avoided using PCs actively sought them out to work on tasks such as writing letters. In fact, for some learners, their computer skills and confidence in those skills were enhanced to such an extent that they felt able to offer support and assistance to their peers.

- **Mobile learning helps to remove some of the formality from the learning experience and engages reluctant learners**

  The ESOL mentor felt that this aspect of traditional learning can often be the most frightening for those who have not previously engaged with learning. He suggested that, as most of the learners in his group were familiar with games machines such as PlayStations or GameBoys, they were quick to respond to using the project's mobile devices and likened the XDA II to a 'turboed Game Boy'. This familiarity with apparently similar technology helped to engage the learners within the class and maintained their interest levels.

- **Mobile learning helps learners to remain more focused for longer periods**

  A mentor told our researcher: 'The group were observed to be remarkably focused and calm during the session when given the devices in contrast to their normal behaviour in the sessions. They were far more focused and gave up to two hours of time to the devices when it is normally difficult to focus them for 15 minutes.'

  It is possible that this effect was due to the novelty of using mobile devices and whether this is the case or not will become clearer over time.

- **Mobile learning helps to raise self-esteem**

  Loaning equipment to young adults to use in their personal environments has resulted in other benefits not directly related to the learning experience. In particular, there have been reports that some of the learners were surprised and proud to be trusted with such expensive and sophisticated technology. For example, one project mentor noted: 'He took really good care of it. He pointed out that because of his background no one else would have ever trusted him with a mobile. This has meant more to him than the actual device itself as he feels respected.' It would seem that the mobile devices are prized highly by the young adults who have taken part. Allowing them personal responsibility for the care of the devices enables them to feel trusted and seems to help to build up their self-esteem. Another boost to some learners' self-esteem came when they realised that as experienced users of mobile phones they possessed useful skills which others perceived as important. Some of these learners became ad-hoc mentors to their peers and gained further self-esteem as a result.

- **Mobile learning helps to raise self-confidence**

  Many mentors observed changes in their learners' level of general self-confidence. This was not specifically linked to the development of their confidence in using ICT or their confidence in the areas of numeracy and literacy, but linked to self-esteem as discussed above. For example, a mentor supporting traveller education stated 'low self-esteem and lack of self confidence [was] much improved when working with others, willing to take risks and try things out. Much gained by discussion with others'. Another mentor reported that a learner who used the driving theory test learning materials 'had not tried it before but by the time he had finished using it he was passing every time. This has given him the confidence to go and learn to drive, as he may not have tried before at the thought of the theory test'.

A matter of trust

When we first discussed with COs lending the mobile devices to the learners (and allowing them to take these away from a classroom or centre) some expressed concerns that:

- devices would be damaged or stolen
- there would be excessive use of the phones for personal calls, including premium rate numbers not connected to the project
- learners might be mugged
- some learners might use the devices inappropriately.

On the other hand, the project team were concerned that too much control of the devices, and their use, would detract from mobility and restrict use by the learners.

Based on some encouraging evidence from previous projects where laptop computers were lent to disadvantaged young people, the project team felt that we, via the mentors, should:

- explain carefully to the learners their responsibilities regarding the devices and their use
- ask them to sign a statement that they understand this (in Mentors' Manual)
- trust them to behave well but monitor their use and set maximum limits for calls etc beyond which phones would be blocked and could only be unblocked via the LSDA helpdesk.

We also felt that we should make it clear to the COs that the project would not expect them to reimburse us for lost or damaged equipment or excess call charges.

Experience suggests that this was the right approach. We have had some loss and damage but, in the context of our learners (including some very disaffected young people) and the locations in which the devices were used, we believe this was kept at an acceptable level. We lent devices to 216 young people and six XDAs were stolen (representing less than 3%). A further two devices (less than 1%) were damaged.

There was some excessive use for non-project activities and when this occurred we temporarily blocked phones and issued warnings that resulted in improved behaviour.

There has only been one reported case of inappropriate use of a device to access a pornographic website. Unfortunately, we were not able to find a way to prevent such access during our learner research and system trials. O_2 was not able to provide a block and we could not find a 'net nanny'-type tool from any other source. However, the tools necessary to restrict website access have recently become available and these will be very important for future projects, particularly projects involving learners under the age of 18.

Section 4 Lessons learned

In addition to the findings of the learner research and system trials we have learned much during the project. This section summarises a few of these lessons in the areas of handsets and infrastructure, learning materials and systems development, and mentor training and support.

4.1 Handsets and infrastructure

Mobile phones and PDAs are no longer just for chatting and organising contacts and diaries, they are now pocket-sized computers and as such have the ability to deliver learning objects and provide access to online systems and services. However, network infrastructure has not quite kept up with handset development, users' expectations or industry hype. As a result, bandwidth is not yet good enough for substantial online learning and coverage and signal problems are still barriers in many areas and when travelling. Therefore, a mixture of online learning and learning using materials downloaded onto handheld devices for use offline is necessary.

4.2 Learning materials and systems development

Although delivering materials in a browser helps, it does not offer full platform independence and there are still standards issues. We have found that it helps to use software layers to insulate learning materials from device-specific features.

An iterative approach to development is best, and developing learning materials specifically for mobile learning is better than re-using materials developed for delivery to a PC.

Attempting to deliver a monolithic mobile learning system is too inflexible in view of the heterogeneous mixture of hardware and services available and the desirability of facilitating blended approaches to learning delivery, particularly for our target audience.

It is important to be aware that, when delivering learning or offering support services to someone's mobile phone, we are encroaching on their personal space.

A flexible, collaborative and pragmatic approach to development works well in an environment where the technologies are new and standards are evolving. This is aided by working collaboratively within a small consortium.

4.3 **Mentor training and support**

For our target audience mentor enthusiasm and involvement seem to be very important for successful mobile learning.

Organisations need to make time for training. Training needs analysis is important for mentors/facilitators, as mobile literacy and confidence varies. Longer training, ongoing access to advice and proactive support in the beginning are all helpful for mentors.

Fast response to mentor (and learner) problems is crucial to avoid disillusionment and stalling momentum. Proactive support, including contacting mentors to ask if they have any problems or need any help, encourages mentors to be more proactive too and can identify issues before they become serious problems.

Mentors, and most learners, need training in the use of PDAs and the more complex hybrid devices. Appropriate and varied support materials are helpful but we observed mixed results from the cascade model.

Section 5 The MLEARN international conferences

Partners within the m-learning project consortium contributed to the first international mobile learning conference – MLEARN 2002. LSDA hosted and co-chaired the very successful MLEARN 2003 international conference, which the m-learning project organised in collaboration with the MOBIlearn project. After the conference, following a process of peer reviewing and editing, papers based on the presentations were published by LSDA in the form of a book *Learning with mobile devices: research and development* (Attewell and Savill-Smith 2004).

We have continued to collaborate with MOBIlearn in the organisation of MLEARN 2004, which was held in Rome in July 2004. Partner colleagues were involved in the programme committee and submitted their own papers. LSDA advised on various aspects of organisation; Jill Attewell, LSDA, co-chaired the conference; and Jill and Tamatha Webster won one of the best paper awards for 'Engaging and supporting mobile learners'.

MLEARN 2004 attracted a worldwide audience including delegates from Australia, New Zealand, the USA and South Africa as well as from many European countries.

Conference delegates were very keen to ensure that the annual international conference continues to provide an opportunity for researchers and developers in this new field to meet and share experiences, achievements and ideas. Several offers to host MLEARN 2005 were received and potential hosts were invited to submit proposals to the MLEARN 2004 conference chairs.

When all proposals had been reviewed, a proposal was accepted from a consortium of South African universities – Tshwane University of Technology, the University of South Africa and the University of Pretoria – to host MLEARN 2005 in Cape Town in October 2005. The MLEARN 2004 conference chairs are contributing to the organisation of MLEARN 2005 and will be co-chairs in Cape Town. For more information please see www.mLearn.org.za.

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The use of mobile technologies to support, enhance and improve access to learning is a relatively new idea and while many teenagers and twenty-somethings are expert mobile phone users many educators are not. This publication provides a quick, plain English introduction to mobile phone technology and summarises the work and findings of the m-learning research and development project. This project investigated the potential of mobile devices for taking learning to young adults with literacy and/or numeracy difficulties.

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